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Taxing Snack Foods: Manipulating Diet Quality or Financing Information Programs?

Fred Kuchler, Abebayehu Tegene, and J. Michael Harris

This paper investigates consumers' likely response to a proposed tax on snack foods that addresses public health issues generated by rising U.S. obesity rates. We estimate demands for particular snack foods and show they are price inelastic after accounting for quality variation. We calculate impacts of a range of ad valorem taxes on the demand for salty snack food. The impacts on dietary quality are small, and negligible at the lower tax rates. If taxes were earmarked for funding information programs, as several proponents suggest, taxes would generate a revenue stream the public health community could use for nutrition education.

Some health activists and health researchers have argued for a tax on snack foods, either to directly influence consumers' diets and health by raising the price of what they say are poor dietary choices or to finance an information program to help consumers choose a healthy diet and lifestyle. Of course, taxes may not be able to satisfy both goals. If consumers' dietary choices can be manipulated with taxes, so that taxes greatly diminish snack food purchases, tax revenues may be sparse, eroding the revenues earmarked to support an information program. Alternatively, if taxes have no power to dissuade consumers from their snack purchases, an information program may be predictably well funded.

Price elasticities are critical information for forecasting tax impacts. This paper investigates consumers' likely response to a tax on snack foods. To examine the extent to which taxes might act as a lever for manipulating dietary choices or raising revenue, we examined a range of ad valorem tax rates to explore tax impacts on quantities of snack food purchased and tax revenues raised.

To estimate household demands for snack foods, we used a unique data set, the AC Nielsen Homescan panel, a nationwide panel of households that scanned their

■ *Fred Kuchler, Abebayehu Tegene, and J. Michael Harris are economists with the Food and Rural Economics Division, Economic Research Service, USDA.*

food purchases (from all retail outlets) at home. Data include detailed product characteristics, quantity, and expenditures for each food item each household purchased. The unit values we calculated account for promotions and coupon use. We used the accompanying demographic information to show that snack food demands vary systematically.

The next section outlines various proposals for taxing snack foods. Following sections detail current taxation of snack foods and the range of possible health and welfare outcomes from a new tax. Next, we describe the data set and the method by which we empirically examined snack food demand. The section also explains how we accounted for quality variation, expressed in prices that each household pays. The results section reports regression results for equations we used to quality-adjust prices and demand equations for salty snacks, followed by a discussion of estimated diet and tax impacts of various tax rates. The concluding section describes the limitations to conducting benefit–cost analyses of programs to tax food and earmark revenues for information programs.

Policy Proposals

The 2001 report *The Surgeon General's Call to Action to Prevent and Decrease Overweight and Obesity* (U.S. Department of Health and Human Services) identified overweight and obesity as major public health problems posing as large a threat of morbidity as poverty, smoking, or problem drinking. Overweight and obesity are associated with an increased risk of many diseases, including coronary heart disease; type 2 diabetes; endometrial, colon, postmenopausal breast, and other cancers; and musculoskeletal disorders, such as knee osteoarthritis. The report said overweight and obesity annually cost U.S. society as much as $117 billion, composed of $61 billion in direct costs and $56 billion in indirect costs. Direct costs include medical expenditures for preventative, diagnostic, and treatment services. Indirect costs include lost wages resulting from people being unable to work because of illness, disability, or premature death (estimated at 300,000 annually). More recent research shows that the direct costs may be larger still, with half of the cost financed by the public sector through Medicare and Medicaid (Finkelstein, Fiebelkorn, and Wang).

These striking findings are leading public health researchers and health policy advocates to search for new ideas to increase the effectiveness of programs designed to influence diet, exercise, and other weight-reducing lifestyle choices. So far, the role of the public sector in managing obesity has been one of providing information, a role it has long tended. The U.S. Department of Agriculture (USDA) has offered dietary advice to consumers for more than a century (Davis and Saltos). Over time, dietary advice has changed, as have the health concerns that dietary advice addresses—from preventing beriberi and scurvy to more modern concerns of minimizing cancer risks and obesity. Now, many agencies throughout the public sector carry out information programs to improve consumers' health and have experience combating obesity.[1]

None of the existing programs are coercive. However, some researchers and health policy advocates have demanded a more prescriptive approach to managing Americans' diets. Several such proposals would impose an excise tax on snack foods. The proposals are not all identical, but collectively cover a small set of goals:

discourage consumption of "junk" food, encourage product reformulation, and provide a source of funding for new information programs about healthy eating.

Taxes and subsidies topped Battle and Brownell's list of policy changes to combat obesity. They argued for taxes on unhealthful foods and subsidies for healthy ones. Although they did not specify a tax level, their purpose in manipulating food prices was to increase consumption of foods they considered "healthy" and decrease consumption of "unhealthy" ones (p. 762).

Nestle listed five classes of changes in public policies intended to promote better diet and lifestyle choices: education reforms, food labeling and advertising reforms, health care and training requirements, transportation and urban development requirements, and taxes. Nestle stated:

> Levy city, state, or federal taxes on soft drinks and other "junk" foods to fund "eat less, move more" campaigns. Subsidize the costs of fruits and vegetables, perhaps by raising the costs of selected foods of minimal nutritional value (p. 367).

She did not specify the tax level or exactly define the foods she would tax. Her proposal is similar to Battle and Brownell's in that the tax is intended to raise snack food prices and lower fruit and vegetable prices, creating an incentive for consumers to substitute fruit and vegetables for snack foods in their diets. Nestle's proposal, however, has a second purpose: to raise revenues to fund an information program.

British researcher Tom Marshall proposed extending the value-added tax (17.5%) to particular foods he considered culpable in raising serum cholesterol levels—those high in saturated fats—and to exempt from taxation those foods currently taxed that are cholesterol-neutral. He argued that this new selective tax would provide incentives for consumers to change their diets and for manufacturers to reformulate foods. In effect, he would tax whole milk but not low fat milk, butter but not margarine.

> Biscuits, buns, cakes and pastries, puddings, and ice cream could be taxed if they raised cholesterol concentrations but exempt if the ratio of polyunsaturates to saturates (and *trans* fatty acids) were more favourable (p. 303).

While his proposal was intended to reduce the incidence of ischemic heart disease, in June 2003 medical associations in England and Australia proposed similar taxes to combat obesity.

Jacobson and Brownell proposed a 1-cent tax per 12-ounce soft drink and 1-cent per pound of candy, chips, and other snack foods, or fats and oils. They argued that Marshall's proposal would be politically infeasible as legislators would prefer to establish tax rates for entire classes of foods, such as snack foods, rather than taxing an attribute like saturated fat levels. They claimed that a tax on snack foods could be justified as taxing foods that play little useful role in nutrition. They did not claim the tax would play a beneficial dietary role. They delved into public finance issues guessing that snack food demands are likely quite price inelastic and taxes would yield small dietary changes. Further, they noted that taxes might even be passed backward through the food supply chain instead of forward. Their plan depends on the proposed tax not reducing consumer expenditures, as the tax revenues would be earmarked to fund an information campaign.

Current Tax Policies

The Federal government has a long history of taxing alcohol and tobacco products. The Federal government levies an excise tax on cigarettes (39 cents per package of 20 [U.S. Department of the Treasury, Bureau of Alcohol, Tobacco, and Firearms]), as do every State, the District of Columbia, and several hundred municipal governments. New York City smokers pay $1.50 per package in taxes to the state government and $1.50 to the city, currently the highest taxes nationwide. The first excise tax in the United States was imposed on distilled spirits (Hu). The Federal government now taxes beer at 5 cents per 12-ounce can, wine at 21 cents per bottle, and distilled spirits at $2.14 per 750 ml bottle.

Throughout U.S. history, only a couple of foods and nonalcoholic beverages have been singled out for Federal taxation. Oleomargarine was taxed from 1886 until 1950 (Gifford). The Federal government twice imposed a tax on soft drinks in the early part of the twentieth century and twice repealed the tax (Holcombe).

State governments have a larger, but variable, impact on food and beverage prices. Among the fifty states and the District of Columbia, forty-six impose sales taxes, with rates as high as 7%. But, twenty-eight states exempt food from their general sales tax. Four states have a reduced rate for food and five allow an income tax credit to offset the sales tax on food (Federation of Tax Administrators).[2]

Many states have, at some time, taxed soft drinks and snack food (Jacobson and Brownell). These taxes have been constructed either as legislation that imposes special taxes or fees on snack foods and soft drinks or as sales tax exemption exclusions for snack foods and soft drinks (Lohman). An exclusion from tax exemption yields the same economic effect as a tax. Seven states currently have specific legislation to tax soft drinks—Arkansas, Missouri, Rhode Island, Tennessee, Virginia, Washington, and West Virginia. Eleven states exclude soft drinks from their sales tax exemptions. Of these, nine also exclude candy and one excludes vending machine sales from exemptions (Lohman; National Conference of State Legislatures).

During the early 1990s, California, Maine, Maryland, and the District of Columbia passed specific legislation to tax snack foods (Grocery Manufacturers Association). These taxes were collected only for a few years. The District of Columbia joined all other states when it repealed its snack food tax in 2001 (District of Columbia, Office of Tax and Revenue).

Potential Policy Outcomes

Carbonated soft drinks could be the largest source of tax revenues from a snack tax. In 1999, U.S. residents on average consumed 49.7 gallons (U.S. Department of Agriculture), equivalent to 530 12-ounce cans. If demand were perfectly inelastic, the Jacobson and Brownell tax scheme could yield as much as $5.30 per capita. Consumption of fats and oils amounted to 60.2 pounds per capita, or as much as $0.60 tax.

Scanner data reveals retail sales of particular snack foods. While there is large variance in the quantity of snack foods individuals purchase, almost everyone buys some snack foods. Tabulations from the AC Nielsen Homescan panel data

Table 1. Salty snack consumption and expenditures

Snacks	Share of Households That Purchased Snacks (%)	Average Quantity Purchased (Pounds)	Per Capita Quantity Purchased (Pounds)	Expenditures by Households
Potato chips	91.3	9.76	4.18	$26.14
All chips	95.5	16.34	7.00	$41.43
Other salty snacks	96.8	16.47	7.92	$37.41
All salty snacks	99.2	31.81	14.47	$76.39

Source: Tabulations from AC Nielsen Homescan panel, 1999.

show that over the course of one year, 91.3% of households purchased potato chips (table 1). On average, these households purchased 9.76 pounds yearly and spent $26.14. Examining a somewhat wider class of snacks—all chips (potato, corn, and tortilla)—shows an even larger share of households (95.5%) that purchased snacks. There are other salty snacks besides chips: pretzels, cheese puffs, microwave popcorn, and nuts (packaged and bulk). These snacks were purchased by 96.8% of households. Considering all salty snacks, 99.2% of households purchased some, on average spending $76.39 yearly on 31.81 pounds.

Given the near universal consumption of snack foods, a snack food tax passed forward to consumers would be paid to some extent by nearly everyone. That does not mean the tax would improve dietary quality or be equitable. The overweight may not find a tax at the checkout counter a sufficient incentive to reduce consumption of foods that give them enjoyment. Some people consume snack foods in moderation and do not need to lose weight.

Of course, both the tax-induced dietary changes and funding for proposed information programs depend on the price elasticity of demand for snack foods. At one extreme, we might find that consumers respond to the tax and price increase by eliminating expenditures on taxed snack foods and purchasing other goods. If consumption of the taxed snacks ends, no revenues will be collected and there will be no money for an information program.

Even if a tax could change consumers' dietary choices, it is not a forgone conclusion that their diets or health would improve. Some consumers might substitute exercise equipment for snack foods and others could choose other foods instead of taxed snacks. If the substitutes were fruit and vegetables, health benefits might be realized. But consumers could substitute decidedly risky goods, say cigarettes, for taxed snacks.

A likely substitution possibility is away from taxed snack foods and toward untaxed snacks. Thus, deciding which snack foods to tax will be difficult. Should foods be taxed on the basis of calories, fat content, or saturated fat content? Which foods are snacks may not be obvious.

Assuming that snack food demands are not perfectly price elastic—and that some tax revenues would be collected for an information program—economists cannot yet assess the entire set of benefits that might flow from the earmarked tax proposals. None of the tax proposals describe exactly how the earmarked funds would be used. There are many messages an information program could convey and many ways to target such messages. However, even without a well-specified proposal for an information program, there are four practical economic questions that can be addressed. First, would such taxes change diets? Second, how much tax would be collected? Third, how big is the excess burden? Finally, on which consumers would the burden be imposed? All four questions depend on the price elasticity of demand for snack foods. The following section describes our methods for estimating households' demands for salty snacks. We focused on these snacks because the demand for such snacks is largely unexplored and the finding that most consumers purchase some salty snacks reduces the need to consider corner solutions.

Methods and Data

The analysis in this study is based on the traditional consumer demand theory. Maximization of utility subject to a budget constraint and non-negativity constraint conditions yields demand equations:

$$q_i = f_i(P, Y, H), \quad i = 1, \ldots, n \tag{1}$$

where q_i is quantity demanded of commodity i, P is vector of prices, Y is total expenditure, and H is vector of variables indicating consumer preferences. Assuming weak separability, sub-group demand equations on food (or food group) can be written as:

$$q_{F_i} = f_{F_i}(P_F, Y_F, H) \tag{2}$$

where F subscript indicates the food subgroup.

Several versions of (2) can be found in the literature. Some researchers use the budget share or expenditure version of the equation to estimate system or single-equation demand functions (e.g., Eales and Unnevehr). Others studies use quantities as dependent variables in the system of equations (e.g., Capps; Park and Capps).

We followed the latter group of researchers in using quantities as the dependent variables. We specified household quantity demanded (q_i) as a function of own price (p_i), substitute prices (p_j), household income (Y), and several continuous variables (h_k, $k = 1, 2, \ldots, K$) indicating household structure. We included other household structure 0/1 variables as intercept shifters (A). Error term u has mean 1 and constant variance.

$$q_i = A p_i^{\beta_1} p_j^{\beta_1} Y^{\gamma} \prod_{k=1}^{k=K} h_k^{\delta_k} e^{u}. \tag{3}$$

To focus on price elasticities, we imposed homogeneity,

$$\frac{\partial \ln q_i}{\partial \ln Y} = -\beta_1 - \beta_2 \tag{4}$$

which yields equations of the following form

$$q_i = A\left(\frac{p_i}{Y}\right)^{\beta_1}\left(\frac{p_j}{Y}\right)^{\beta_2}\prod_{k=1}^{k=K} h_k^{\delta_k} e^u. \tag{5}$$

A log transformation yields linear functions[3]

$$\ln q_i = \ln A + \beta_1 \ln\left(\frac{p_i}{Y}\right) + \beta_2 \ln\left(\frac{p_j}{Y}\right) + \sum_{k=1}^{k=K} \delta_k \ln h_k + u. \tag{6}$$

Intercept shifters allow for differences along categorical lines

$$\ln q_i = \alpha_1 + \alpha_2 D + \beta_1 \ln\left(\frac{p_i}{Y}\right) + \beta_2 \ln\left(\frac{p_j}{Y}\right) + \sum_{k=1}^{k=K} \delta_k \ln h_k + u. \tag{7}$$

This study uses household purchase information from AC Nielsen Homescan panel data, in which households scan their food purchases at home. Unlike point-of-sale scanner data, the AC Nielsen Homescan panel data contains purchase as well as demographic information. The benefits and costs of using scanner data for economic analysis were recognized as soon as scanner data became available. Cotterill pointed out that the point-of-sale scanner data and the household panel data "... are the core data for market research in the private sector." The former, collected as items are scanned at grocery stores, are often used to measure product flow, while the latter are used to measure which consumers are buying particular products. He noted point-of-sale scanner data enables analysis of strategic interactions among rival food suppliers, but household panel has some advantages for demand analysis.

While demand theory is based on individual preferences, prices, and income, empirical work is usually conducted with aggregated data. The panel data allows analysis based on household choices. The attribute details that accompany the purchase information make it possible to analyze systematic differences in demand functions. The panel data reveals which households buy particular products and which reject them. Of course, household data takes us close, but does not reach the level of individual choices.

As Capps noted, scanner data is incomplete from a consumer demand perspective. Fast food and restaurant meals are not included, nor are vending machine sales. However, AC Nielsen contracts with individuals to record their food purchases (rather than contracting with stores) so the household panel data includes sales from all types of stores, regardless of size. The most difficult completeness question to answer is whether participants are vigilant in recording their purchases.

We used the random weight panel, which is a subset of the full panel (12,000 households). Households in the subset scanned both fixed weight products (with a universal product code [UPC]) and random weight products (e.g., meat and poultry, fruit and vegetables). From this set, we drew data from households that were in the panel for at least ten out of the twelve months in 1999—7,195 households.

The data are a stratified random sample, projectable to the U.S. universe of product purchases. The sample was selected based on both demographic and geographic targets. Stratification was done to ensure that the sample matches the U.S. Census. The household was the primary sampling unit and there was no intentional clustering. Our ordinary least squares (OLS) regressions and descriptive statistics account for the sample design through stratification. The weight assigned to each household reflects the demographic distribution within strata. We used SAS Surveyreg procedure for regression analysis and Surveymeans procedure to calculate descriptive statistics. These procedures yield parameter estimates identical to conventional regression methods, but with unbiased standard errors. Accounting for survey design imposes some limits on analysis. We are unaware of any statistical package that accommodates complex sample design in a system of equations framework. Thus, our estimation procedure is limited to single equation estimation.

To isolate the impact of prices from other factors, we examined the effect of household characteristics and attributes and regional influences. Household characteristics and attributes include household size, age of head (male and female), education of head (whether or not at least one household head attended some college), marital status, whether household income is above or below 130% of the poverty threshold,[4] presence or absence of children aged six and older, and race/ethnicity. We included dummy variables for four regions and urban and metro classifications. One classification was eliminated from each group of categorical variables for estimation purposes. The base group is households that satisfy the following description: Income above 130% of the poverty level; unmarried; no children aged six and older; household head did not attend college; household head of Hispanic origin; and from the rural, Central region. Table 2 presents descriptive statistics for the variables used in the analysis.

Post-sample weighting makes the data closely match Census projections for 1999 for regional proportions, for sample proportion residing in urban areas, and for the proportion of households for which household heads are married (U.S. Census Bureau). However, the sample is not a perfect match in all dimensions because the data were drawn from households that are relatively smaller than the Census average (2.56 members instead of 3.18 members). The sample also under-represents the extent of poverty (9% instead of 13%) and over-represents the number of non-Hispanic white consumers (79% instead of 72%). In effect, it appears that it is relatively more difficult to recruit panelists from large, lower-income, minority families.

The data provide information on expenditures for precisely described products. There are many attributes that can differentiate products. Potato chips, for example, might be differentiated by manufacturer, product size, flavor, or fat content, each with a unique UPC. The AC Nielsen Homescan panel provides brand codes, variables indicating product attributes, and UPCs. In the data set, potato chip purchases display 2,393 unique UPCs. The challenge of using such a rich data set for demand analysis is appropriately aggregating data to depict an individual product and the price. With the vast array of purchased food products identified, it is not always obvious how to accommodate the law of one price.

For analysis, prices have to be imputed. The data include both expenditure and quantity information for individual purchases. We subtracted the coupon

Table 2. Descriptive statistics for variables used in analysis

Variable	Mean	Standard Error of Mean	Number of Households
Quantity (dry oz.) of			
Potato chips	156.28	3.6521	6,638
Other chips	132.43	3.5149	5,990
All chips	261.57	5.3788	6,935
Other salty snacks	263.49	6.2972	6,638
Price (cents/lb.) of			
Potato chips	17.81	0.1321	6,638
Other chips	15.55	0.1142	5,990
All chips	16.74	0.1124	6,935
Other salty snacks	16.17	0.1658	6,986
Numerical control variables			
Household size	2.56	0.0338	7,195
Income ($thousand)	41.99	0.5559	7,195
Age of household head (years):			
Female	43.33	0.3423	7,195
Male	41.90	0.3428	7,195
0/1 variables			
In poverty	0.09	0.0092	7,195
Married	0.51	0.0115	7,195
Kids	0.27	0.0104	7,195
Education	0.69	0.0117	7,195
Non-Hispanic white	0.79	0.0102	7,195
Non-Hispanic black	0.11	0.0084	7,195
Non-Hispanic other	0.01	0.0015	7,195
Asian	<0.01	0.0011	7,195
Hispanic	0.09	0.0070	7,195
Urban	0.78	0.0092	7,195
West	0.21	0.0052	7,195
East	0.19	0.0048	7,195
South	0.36	0.0083	7,195
Central	0.24	0.0056	7,195

value, if any, to compute actual expenditure on each purchase. We computed a price for each household dividing the sum of annual expenditures by quantities. This gives us an annual average price for each snack food for each household.

Cox and Wohlgenant and Park and Capps, among others, have demonstrated the importance of adjusting prices for "quality" effects, which result from commodity aggregation in cross-sectional data. Failure to quality-adjust cross-sectional prices results in biased elasticities of demand, and the bias increases with the heterogeneity of commodity aggregates (Cox and Wohlgenant). We followed Cox and Wohlgenant and Park and Capps, where household and other socioeconomic variables were used as proxies for household preferences over unobserved quality characteristics, to quality-adjust the imputed prices.

We made quality adjustments to prices by regressing the imputed prices on household characteristics and other demographic variables. Similar to Cox and Wohlgenant and Park and Capps, we computed the quality-adjusted prices as:

$$(8) \quad p_i = f_i[(\text{household size, household size squared, income, income squared, age of household head}), (\text{income below poverty line, married, presence of children age 6 and up, household head attended college, race/ethnicity, urban/rural, region})]$$

where p_i is the imputed price; the first set of variables in parentheses consists of continuous variables and the second set consists 0/1 variables.

Quality-adjusted prices were generated by adding the intercept of equation (8) to the residuals of (8) (Cox and Wohlgenant; Park and Capps). Table 3 presents the results from estimating equation (8). The coefficients of household size and income

Table 3. Regression results for price/quality functions for salty snack foods

	Dependent Variables (Unit Values)			
Household Characteristic	Potato Chips	Other Chips	All Chips	Other Salty Snacks
	Coefficient Estimates			
Intercept	19.2446***[a]	15.8390***	17.8135***	17.7725***
Income	0.0214	0.0120***	0.0204***	0.0592***
Income squared	0.0000	−0.0004***	−0.0000	−0.0002
Household size	−0.8419***	−0.5991***	−0.8122***	−1.2046***
Household size squared	0.0544*	0.0256	0.0449*	0.0814**
Age of male household head	−0.0175***	0.0078	−0.0100**	−0.0086
Age of female household head	−0.0025	−0.0254***	−0.0000	0.0062
In poverty	−0.2805	0.7317***	−0.3077	0.3369
Married	−0.7640***	−0.0803	−0.2115	−0.0241
Kids	−0.3149	0.4974***	0.0742	−0.7400***
Education	0.5658***	−0.1612	0.1974	−0.2658
Non-Hispanic white	−0.7703***	−0.2064	−0.3802*	−0.6406*
Non-Hispanic black	−0.0194	1.7618***	0.7410***	0.7581*
Non-Hispanic other	1.830**	1.5420**	1.3641**	−0.3279
Asian	1.7954	0.6780	0.7476	−1.5200
Urban	−0.0250	−0.1610	0.0267	−0.0719
East	0.4357**	0.3344*	0.3247*	−1.0080***
West	1.1008***	−0.9163***	−0.1848	0.5685**
South	1.7080***	0.1217	1.0029***	−0.1995
R^2	0.0629	0.0582	0.0474	0.0330
Number of observations	6,637	5,989	6,934	6,985

[a]Significance levels of 0.01, 0.05, and 0.1 are indicated by ***, **, and *, respectively.

and the quadratic terms have the expected signs in all three price equations, although not all coefficients are significant.

All prices used in subsequent demand estimation were quality-adjusted. Although it is difficult to assign expected signs to the coefficients of some of the variables in the demand equation (equation [7]), we expected that household size and households with children aged six and over would be positively correlated with snack consumption. Quadratic specification for household size and income are included to capture economies of scale in purchasing as well as increases in quality which are hypothesized to increase with income (Cox and Wohlgenant). Thus, household size (income) is expected to have negative (positive) linear and positive (negative) quadratic impacts in equation (8). In equation (7), we expected the coefficient of the education variable to be negative. Studies have shown that diet quality is associated with both education attainment and household income (Variyam and Blaylock). Thus, the sign of the poverty variable was expected to be positive. We did not hypothesize signs for the coefficients of the regional and ethnic/race variables.

Results

Table 4 presents the results from estimating single equation demand functions for potato chips, all chips, and other salty snacks (equation [7]). Other chips (corn chips and tortilla chips) were assumed to be substitutes for potato chips in the potato chips equation. Similarly, all chips (potato, corn, and tortilla) and other salty snacks (popcorn, pretzels, cheese puffs, nuts) were assumed to be substitutes to each other.

The demand for potato chips is inelastic (−0.45) and significant at the 5% level. The cross-price elasticity has the correct sign (positive) and is also significant. Other than prices, household size, presence of children of age six or older, ethnicity, and regional differences are the variables that significantly influence the demand for potato chips. Household demand for potato chips increases with household size, and with families with children aged six or older. The significance (at the 10% level) of the coefficient of the household size squared term indicates the presence of economies of scale in purchase of potato chips. Non-Hispanic white and non-Hispanic black households consume more potato chips than Hispanic households. The results also indicate that there are regional differences in the demand for potato chips. Households in the Central region consume more potato chips than the other regions.

The results from estimating the demand for all chips are, for the most part, similar to the demand for potato chips. Own price is inelastic (−0.22) and significant, while price of other salty snacks does not affect the demand for chips. The coefficient for household size is significant, as is the coefficient of household size squared (at the 10% level), implying economies of scale.

The demand for all chips shares features with the demand for potato chips: households with children aged six and older consume more chips than other households. While non-Hispanic black households appear to consume more potato chips than Hispanic households, there is no significant difference in consumption when all chips are considered. On the other hand, non-Hispanic white households consume not only more potato chips, but also all kinds of chips, than Hispanic households.

Table 4. Regression results for salty snack demands—accounting for survey design

	Dependent Variables (ln [quantities])		
Explanatory Variables	**Potato Chips**	**All Chips**	**Other Salty Snacks**
	Coefficient estimates (*t*-statistics)		
Intercept	3.0909	4.9427	1.301
	(5.72)	(11.38)	(3.26)
ln(Potato chip price/income)	−0.4541	–	–
	(−3.96)		
ln(Other chip price/income)	0.3005	–	–
	(3.10)		
ln(All chip price/income)	–	−0.2211	0.4208
		(−2.44)	(5.33)
ln(Other salty snack price/income)	–	−0.0013	−0.6919
		(−0.02)	(−9.28)
ln(Household size)	0.6440	0.6455	0.2541
	(3.91)	(3.96)	(1.61)
ln(Household size^2)	−0.1559	−0.1386	−0.0413
	(−1.80)	(−1.63)	(−0.48)
ln(Age of male household head)	0.1607	−0.0360	0.4730
	(1.63)	(−0.40)	(5.95)
ln(Age of female household head)	0.0637	−0.1102	0.4180
	(0.65)	(−1.38)	(5.46)
In poverty	0.1913	0.1560	−0.0313
	(1.54)	(1.49)	(−0.25)
Married	0.1030	0.1867	0.0269
	(1.29)	(2.39)	(0.38)
Kids	0.3413	0.3925	0.1924
	(4.08)	(5.26)	(2.72)
Education	−0.1075	−0.0694	−0.0499
	(−1.50)	(−1.18)	(−0.89)
Non-Hispanic white	0.4230	0.2313	0.2265
	(3.30)	(2.48)	(2.47)
Non-Hispanic black	0.3423	−0.1378	−0.2771
	(2.22)	(−1.10)	(−2.16)
Non-Hispanic other	0.0462	0.0489	0.4756
	(0.23)	(0.26)	(2.30)
Asian	0.0824	0.1725	0.0330
	(0.40)	(0.81)	(0.16)
Urban	−0.0787	−0.0485	−0.0334
	(−1.19)	(−0.75)	(−0.59)
East	−0.2158	−0.4103	−0.0207
	(−3.20)	(−6.88)	(−0.38)
West	−0.2576	−0.1021	−0.0236
	(−4.01)	(−1.87)	(−0.41)
South	−0.2021	−0.1987	−0.1354
	(−2.87)	(−3.10)	(−2.16)
R^2	0.1563	0.2083	0.2044
Number of observations	5,689	6,771	6,771

The last column of table 4 shows the results from estimating the demand for other salty snacks. Both own- and cross-price elasticities are significant and have the correct signs. Although still inelastic, both price elasticities for other salty snacks are larger than the price elasticities for potato chips and all chips. Other significant variables include the presence of kids, age of household head, ethnic origin, and region. Non-Hispanic white households consume more other salty snacks than Hispanics. However, Hispanics consume more than non-Hispanic blacks. Regional differences in the consumption of other salty snacks are less evident than for potato chips or all chips. Households in the Central region consume more other salty snacks than households in the South; there is no significant difference with other regions.

Overall, the results presented in table 4 show that, in addition to prices, household size, presence of children, age of household head, ethnicity, and region significantly influence consumption of salty snacks. Other variables we examined, including poverty status, marriage, and education, are marginally significant or not significant at all. The own-price elasticity estimates are similar in magnitude to estimates for cigarettes and alcohol, other consumer goods that have been taxed for many years. In their review of empirical studies of cigarette demand, Chaloupka and Warner concluded that most price elasticity estimates fall within the range of −0.3 to −0.5. Similarly for alcohol, Cook and Moore reported estimates of −0.35 (beer), −0.68 (wine), and −0.98 (spirits).

Exploring Tax Impacts

Our goal for estimating household demand was to be able to explore diet and tax revenue implications of various tax schemes—different tax rates, varying from putatively small to coercively large, and different tax bases, where taxes might be imposed on specific salty snacks or the entire class. We made several assumptions to make the analysis tractable. Under the assumption that the supply side of snack food markets is competitive and that there are no specialized factors of production, average and marginal costs can be assumed constant. In effect, any tax will be fully passed forward to consumers.[5] Further, the percentage change in each snack food price will be exactly equal to the tax rate. Thus, from the definition of price elasticity, we can write the tax-induced change in quantity purchased, ΔQ, in terms of the pre-tax purchase level Q, the ad valorem tax rate τ, and the price elasticity η, namely $\Delta Q = \tau Q \eta$. As our regressions yielded estimates of own- and cross-price elasticities, η_o and η_s, we treated ΔQ as the result of two price effects and modified the equation to include both price elasticities when we calculated impacts resulting from taxing multiple types of salty snacks: $\Delta Q = \tau Q(\eta_o + \eta_s)$.

We used mean annual household purchases of different salty snack foods and the estimates of own- and cross-price elasticities to calculate changes in quantities purchased. Table 5 shows results for three tax rates (1, 10, and 20%) and three tax bases (potato chips, all chips, all salty snacks). Impacts were calculated on potato chips, all chips, and other salty snacks.

While a 1% tax may sound small, it is approximately three times larger than the Jacobson and Brownell proposal of 1 cent per pound. Nevertheless, the calculated dietary changes induced by a 1% tax are quite small. The estimated price elasticity for potato chips indicates that if such a tax were imposed on potato chips alone,

Table 5. Diet and tax revenue impacts of ad valorem taxes on salty snack foods

Tax Rate	Tax Base	Response	Reductions in Annual Quantities Purchased: Household	Reductions in Annual Quantities Purchased: Per Capita	Tax Revenue Collected per Household
Percent			Dry Ounces		Dollars
1	Potato chips	Potato chips	−0.71	−0.28	0.26
10	"	"	−7.09	−2.77	2.50
20	"	"	−14.19	−5.54	4.75
1	All chips	Potato chips	−0.24	−0.09	0.26
10	"	"	−2.40	−0.93	2.57
20	"	"	−4.80	−1.87	5.07
1	All salty snacks	All chips	−0.58	−0.23	0.41
10	"	"	−5.78	−2.26	4.05
20	"	"	−11.57	−4.51	7.92
1	All salty snacks	Other salty snacks	−0.71	−0.28	0.37
10	"	"	−7.14	−2.79	3.64
20	"	"	−14.29	−5.57	7.08

the tax would reduce annual household purchases (average of 156.28 ounces) by 0.71 ounces. The reduction is equivalent to 0.28 ounces per person a year, or 42 calories per person. The 20-percent tax reduces purchases by 5.54 ounces per person per year, or 830 calories. Assuming that no food would be substituted, at 3,500 calories per pound of body weight (American Dietetic Association), the reduction translates into less than a fourth of a pound.

Widening the tax base to include all chips means smaller tax impacts on potato chips as cross-price effects partially offset the own-price effects. The calculated 0.09 ounce reduction in per capita purchases is equivalent to 14 calories a year.

Widening the tax base to include all salty snacks yields qualitatively similar results. Impacts in the all chips category and on other salty snacks are both calculated less than 0.3 ounces for the 1% tax rate. Even at the 20% rate, reductions in purchases fall in the range of 4–6 ounces per person.

We calculated tax revenue raised per household as $\tau P(Q + \Delta Q)$, substituting $\tau Q\eta$ for ΔQ as above when one snack is taxed and substituting $\tau Q(\eta_o + \eta_s)$ to identify own- and cross-price effects: tax revenues per household are $\tau P[Q + \tau Q(\eta_o + \eta_s)] = \tau PQ[1 + \tau(\eta_o + \eta_s)]$. Household expenditures, tax rates, and estimated elasticities are sufficient for calculating tax revenues. Estimates appear in table 5.

The relatively small magnitudes calculated for taxes per household understate their revenue raising potential. The 2000 Census counted 105.5 million households. Even the $0.26 tax collected from a 1% tax on potato chips implies $27 million that could be earmarked for information programs. At the 20% tax rate, where households pay $5–8, the aggregate tax revenue might range from $500 to $700 million per year.

Conclusion

This analysis answers some, but not all, economic questions that might be raised about taxing snack foods. It is obvious that a small tax on salty snacks would have very small dietary impacts. Even a larger tax would not appreciably affect overall dietary quality of the average consumer. We have examined one type of snack food. A tax imposed on the entire range of snack foods (e.g., soft drinks, sweet snacks, fats, and oils) may or may not affect dietary quality. The more certain results are that price changes do not appear to induce major changes in consumers' salty snack choices. Thus, a tax could be used to raise earmarked revenues.

When economists evaluate the welfare implications of taxation, they often make an uncharacteristically generous assumption. They focus on the magnitude of welfare triangles, namely the value of missed opportunities for sales. These triangles measure the sum of lost producer profits and the losses consumers sustain from choosing consumption bundles less attractive than their pre-tax choices. From an economic welfare perspective, tax revenues are often considered irrelevant, as taxes are simply said to be a transfer. In effect, economists assume that since they do not know how the tax revenues will be used, they can safely assume that the public sector will use tax revenues wisely: each tax dollar will be used to purchase goods that taxpayers value at a dollar.

Several of the snack tax proposals earmark funds for an information program, so we do know how the tax revenues could be used. We do not have to assume program benefits will match expenditures. However, no analysis can yet answer whether earmarking taxes would be economically efficient. The existence of program benefits depends on the effectiveness of the, as yet, unspecified information program. Diet and health benefits of an information program cannot be estimated in the abstract; judging whether net benefits are positive will have to wait until proponents reveal program details.

Even if we knew the form of proposed information programs, it would be difficult to confidently predict the sign of net benefits. The coexistence of rising obesity rates and continued public sector information programs indicates that it is unlikely that a marginal increase in program magnitude will make obesity disappear. But there is evidence that some government nutrition information programs do meet a benefit–cost test. An analysis of the Virginia Adult Expanded Food and Nutrition Education Program (EFNEP) tallied the dollar benefits of avoiding or delaying the health-care costs and losses of productivity associated with ten nutrition-related diseases/conditions (Lambur et al.). The benefit–cost ratio, 10.64, was based on evidence that the dietary changes attributed to education would persist indefinitely. Such results beg the question whether EFNEP participants are unusually able to benefit from nutrition education and whether similar programs can be scaled up for others.

Obvious attributes of U.S. marketing suggest that this possibility is unlikely. A short-term program that would be widely used and offer long-term weight reduction has so far eluded the private sector despite a huge financial incentive to find such a program.[6] Food advertisements on children's television program shows are typically repeated frequently, indicating that food manufacturers believe the effectiveness of their information does not persist, but decays very rapidly.

That is, the range of benefits possible from a new program might include zero. While it is possible that the existing programs slowed the rise in obesity, we can see that these programs were not sufficient to stop or reverse the rise. An information program with demonstrable health benefits might have to issue entirely different types of messages than those already tried.

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Endnotes

[1]USDA runs several programs that are aimed at preventing obesity and promoting healthy eating. These include the Expanded Food and Nutrition Education Program (EFNEP) (for low-income youth and low-income families with young children), Food Stamp Nutrition Education, and the Special Supplemental Nutrition Program for Women, Infants, and Children, popularly known as WIC.

[2]In our analysis, we ignored sales taxes because we cannot identify the state where each respondent shops. Variance in local sales taxes (the maximum of which are higher than the corresponding state rate in six states) exacerbated the problem.

[3]We experimented with Box-Cox transformations to choose between linear and log-linear specifications. Linearity was rejected, but the log-linear model was not rejected at the 5% level of significance.

[4]Panel members identified a range of values in which their household income fell in 1999. We treated each observation as the midpoint of the range. To construct the poverty variable, we compared imputed income to poverty thresholds, accounting for household size.

[5]While the theoretical literature on how prices react to taxes is vast, the empirical side is relatively small and in dispute. Poterba found broad support for the view that retail sales taxes are fully forward shifted, raising consumer prices by the amount of the tax increase. Besley and Rosen found a variety of shifting patterns.

[6]A Federal Trade Commission report cites private sector data indicating the total U.S. weight-loss market for 2001 is estimated to be $37.1 billion and growing at a rate of 6–7% a year.

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